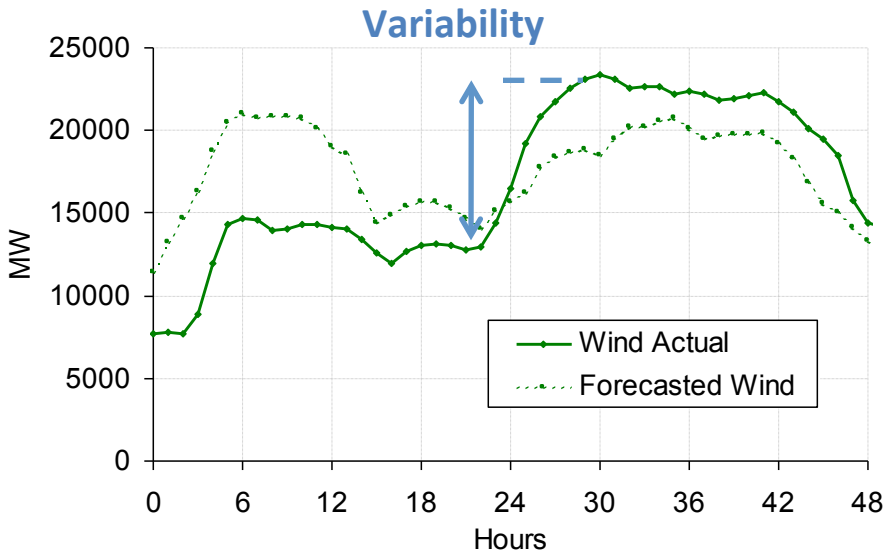
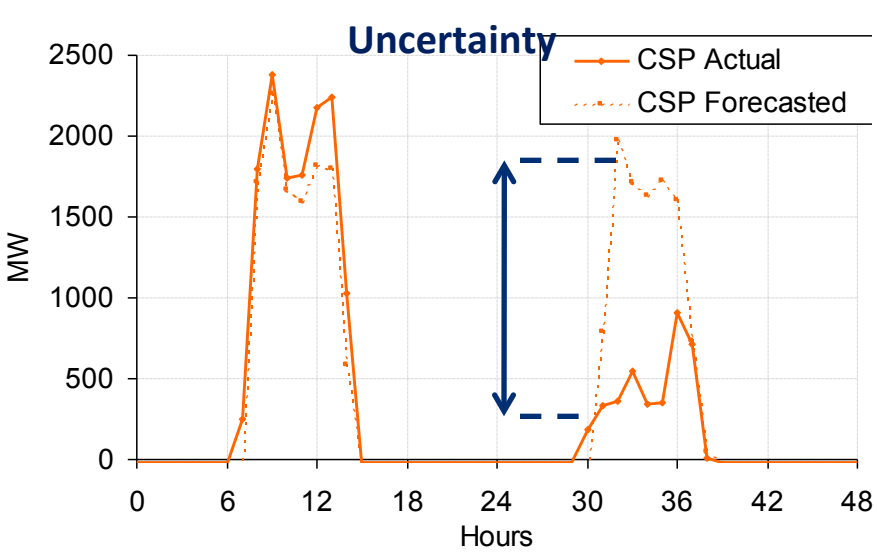
Why do we need reserves?

- Uncertainty in load, wind, solar
- Variability in load, wind, solar that is not accommodated in scheduling.





Reliability standards

- CPS1: Each BA must maintain CPS1 score of 100% during 12-month rolling horizon. Used to minimize ACE that impacts frequency.
- CPS2: Each BA needs to keep 10 min average of ACE below L10 for 90% of the time. Used to reduce excessive interchange error and inadvertent interchange.
- RBC/BAAL: Frequency based limit. For each BA, ACE cannot exceed BAAL limits for >30 minutes. Replaces CPS2.
- Europe Regulation: $Reg = \sqrt{10L + 150^2} - 150$

EWITS reserves

TABLE 5-5. SUMMARY OF RESERVE METHODOLOGY FOR STUDY SCENARIOS		
RESERVE COMPONENT	**SPINNING (MW)**	**NONSPINNING (MW)**
REGULATION (VARIABILITY AND SHORT-TERM WIND FORECAST ERROR)	$3\times\sqrt{\left(\frac{1\%\cdot HourlyLoad}{3}\right)^2+\sigma_{ST}(HourlyWind)^2}$	0
REGULATION (NEXT-HOUR WIND FORECAST ERROR)		0
ADDITIONAL RESERVE	$1\times\sigma_{NextHourError}\ (PreviousHourWind)$	2 × (Regulation for next hour wind forecast error)
CONTINGENCY	50% of 1.5 × SLH (or designated fraction)	50% of 1.5 × SLH (or designated fraction)
TOTAL (USED IN PRODUCTION SIMULATIONS)	**SUM OF ABOVE**	**SUM OF ABOVE**

Wind variability from EWITS

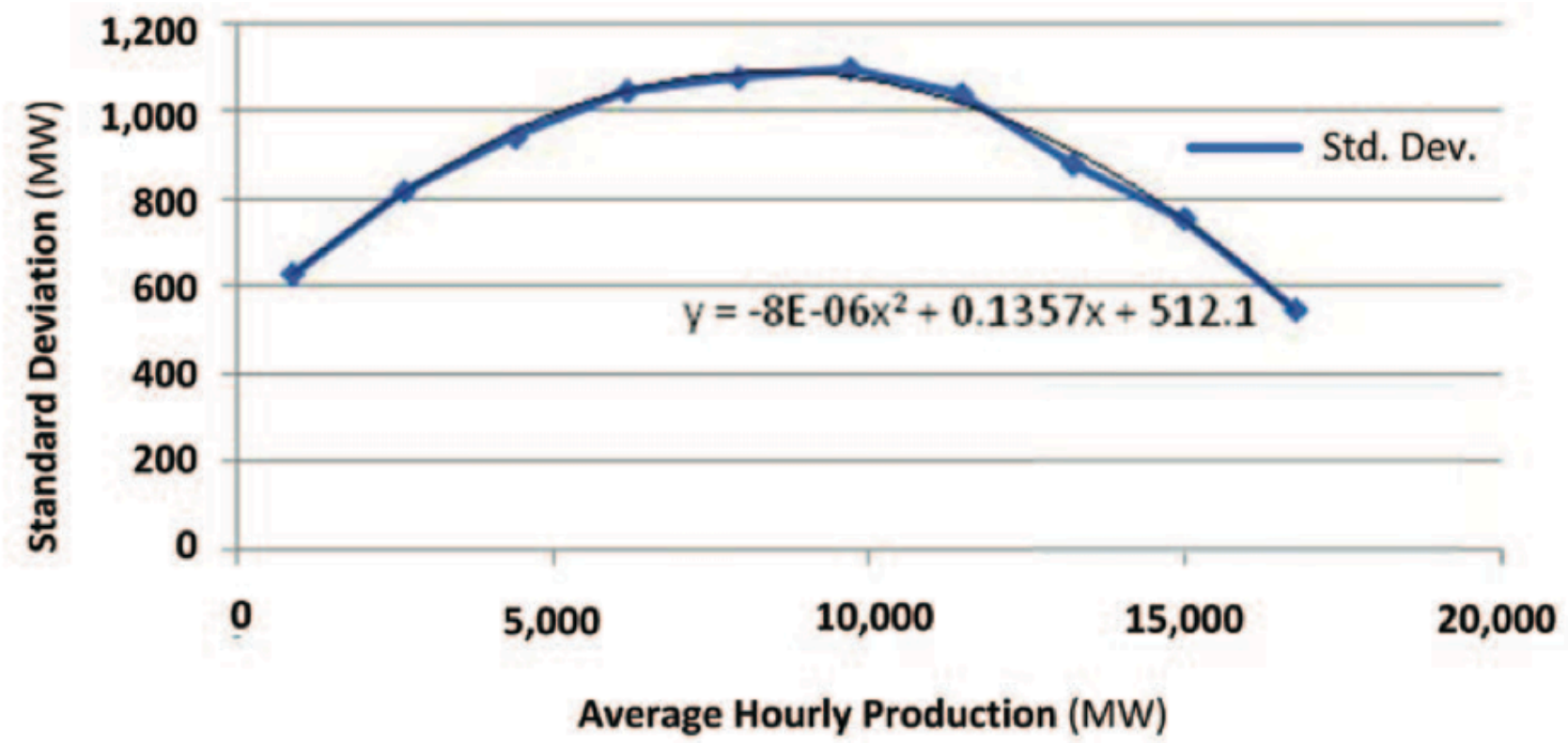
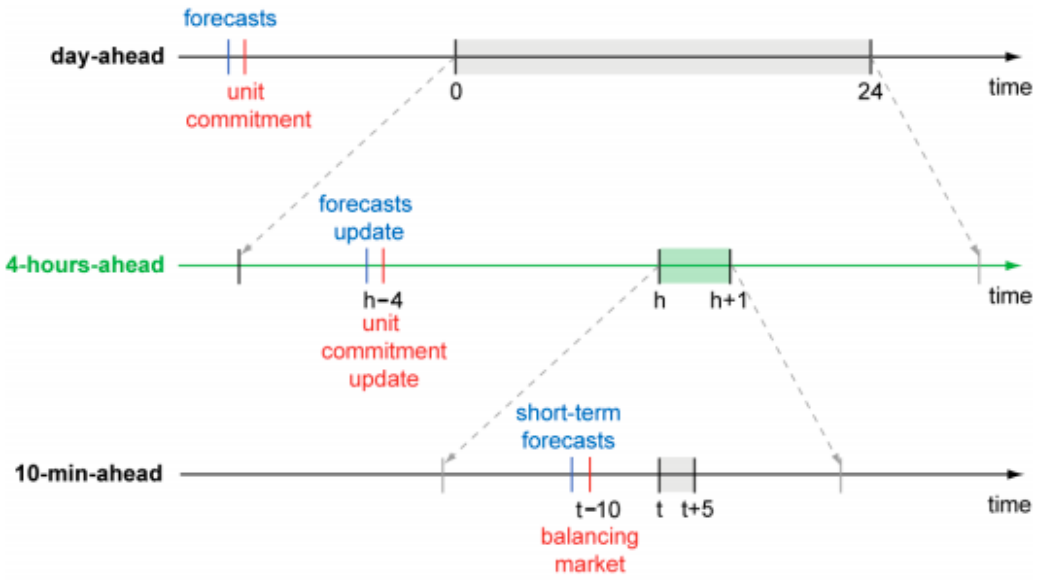


Figure 5-10. Standard deviation of 1-hour persistence forecast error for PJM in

Plexos Simulations

- DA – unit commitment based on DA wind/solar forecasts (no load forecast error)
- 4 hour ahead – commit CC units based on 4 hour wind/solar forecasts
- 5 minute economic dispatch – with 55 min look-ahead



Contingency Reserves

- 6% of load
- 50% of requirement spinning (online).
- 10-minute ramp constraint for online requirement
- Only model online spinning reserve

Reg

- EWITS Requirement

$$Reg = 3\sqrt{(\frac{.01 * HourlyLoad}{3})^2 + \sigma_{ST}(HourlyWind)^2}$$

  - All spinning (online)
  - Standard deviation of 10-minute ahead wind forecast errors based on hourly wind power output.
  - 10-minute forecast errors based on a persistence forecast
  - 3 standard deviations catches 99.7%
- WWSIS2 Methodology, same as EWITS with exceptions:
  - Use percentiles of forecast error distributions for 10-minute ahead forecasts rather than assuming normal distributions.
    - Starting with 95%
  - Solar forecasts adjusted by clear sky index instead of pure persistence
  - Load forecasts use predicted ramp
  - 5-minute ramp constraint
- Reg reserves shared across WECC to simulate RBC
- Assume wind, solar, load uncorrelated in this time frame

Flex Reserves

$$Flex - spin = 1\sigma_{Next\ Hour\ Error}(Previous\ Hour\ Wind)$$
$$Flex - total = 3\sigma_{Next\ Hour\ Error}(Previous\ Hour\ Wind)$$

- EWITS Requirement
  - Total can be met by offline CTs (not modeled)
  - Standard deviation of hour-ahead wind forecast errors based on previous hours wind power output.
  - Hour-ahead forecast errors based on a persistence forecast
  - 3 standard deviations catches 99.7%, online 68%
  - When under forecast, real-time released amount of reserves (i.e., the amount used no longer had to be held)
- WWSIS2 Methodology, same as EWITS with exceptions:
  - Use percentiles of forecast error distributions for hour-ahead forecasts rather than assuming normal distributions.
    - Starting with 68% online requirement (may change based on model simulations)
    - Not modeling nonspin requirement (nonspin can be used, however)
  - Solar forecasts adjusted by clear sky index instead of pure persistence
  - 60-minute ramp constraint (may change based on model simulations)
  - **Load: Assume no contribution to flex?**
  - **Question: Hour-ahead or 4-hour ahead?**
- Flex reserves for each of 21 WECC LRS Zones
- Held in day-ahead and 4-hour-ahead, if under forecast in real-time, released.

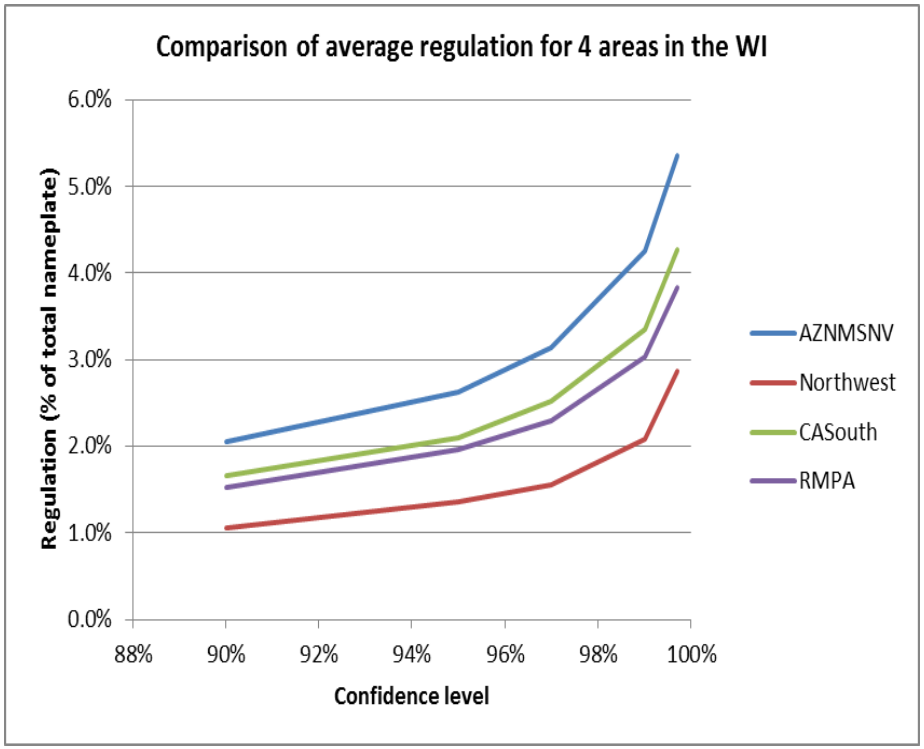
Reserves Summary

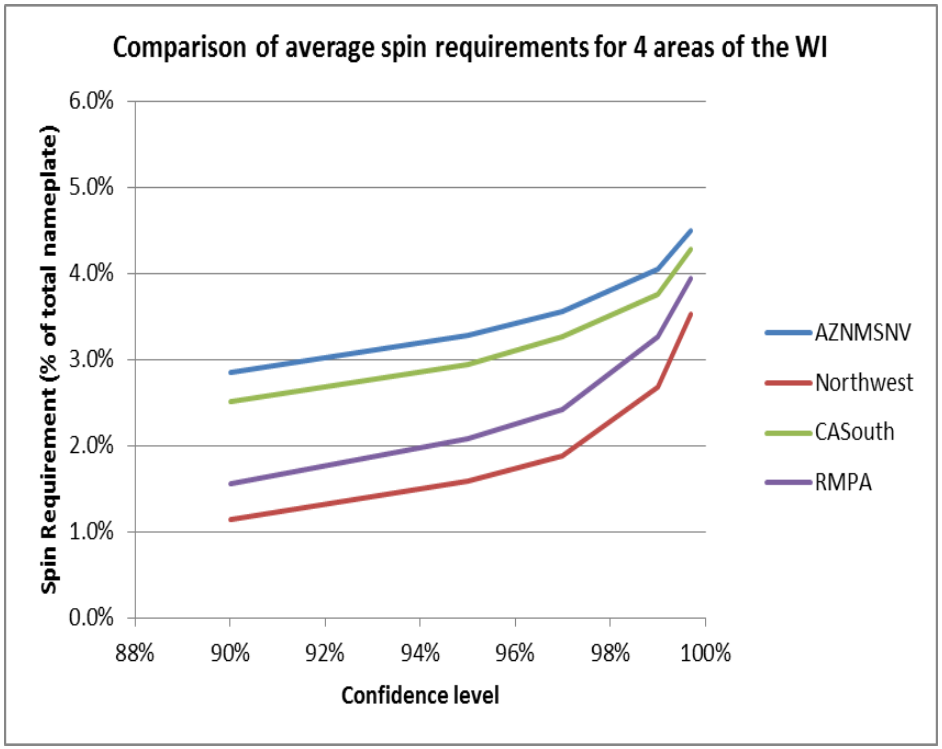
Type	Contingency	Regulation	Flex
Purpose	Contingencies (Instantaneous loss of supply)	AGC correction of economic dispatch	Slower occurring Load, wind, and solar forecast error
Time resolution	10-min	5-min	60-min
Model usage	Held in all, never deployed	Held in all, never deployed	Held in DA, 4HA, Deployed in RT
Reserve Sharing Group Size	21 WECC LRS zones	All of WECC (represents RBC)	21 WECC LRS zones
Methodology	3% load	95% of 10-minute ahead forecast errors	68% of Hour-ahead forecast errors

Model up-reserves and online reserves only

Extra slides

Confidence interval





Suggest picking 95%